Spring Security

About me

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– CEO of **IPT – Intellectual Products & Technologies**
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– Oracle® certified programmer 15+ Y

– end-to-end reactive fullstack apps with Java, ES6+, TypeScript, Angular, React and Vue.js

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Where to Find The Code and Materials?

Java Academy projects and examples are available @GitHub:

https://github.com/iproduct/java-spring-academy-2022.git

Security Basic Concepts

- Authentication
- Authorization
- Data integrity
- Confidentiality
- Non-repudiation
- Auditing
- Quality of Service
- Role
- Realm
- User
- Group
- Principal

Key Java Security APIs - I

- Java Authentication and Authorization Service (JAAS) – defines an extensible model for adding new pluggable authentication and authorization modules (PAM)
- JavaGeneric Security Services (Java GSS-API) – token-based API for secure exchange of messages unifing access to different security mechanisms such as Kerberos
- Java Cryptography Extension (JCE) – provides ability to encrypt, generate, and agree upon keys of symmetric, asymmetric, block and stream cyphers.

Key Java Security APIs - II

- Java Secure Sockets Extension (JSSE) – provides SSL and TLS transport layer security protocols implementation in Java, allows messages encryption, server (and optionally client) authentication, securing messages integrity.
- Simple Authentication and Security Layer (SASL) – standard for defining an authentication protocol, defining a security layer between client and server applications, providing a framework for implementing concrete authentication mechanisms.

Security Approaches

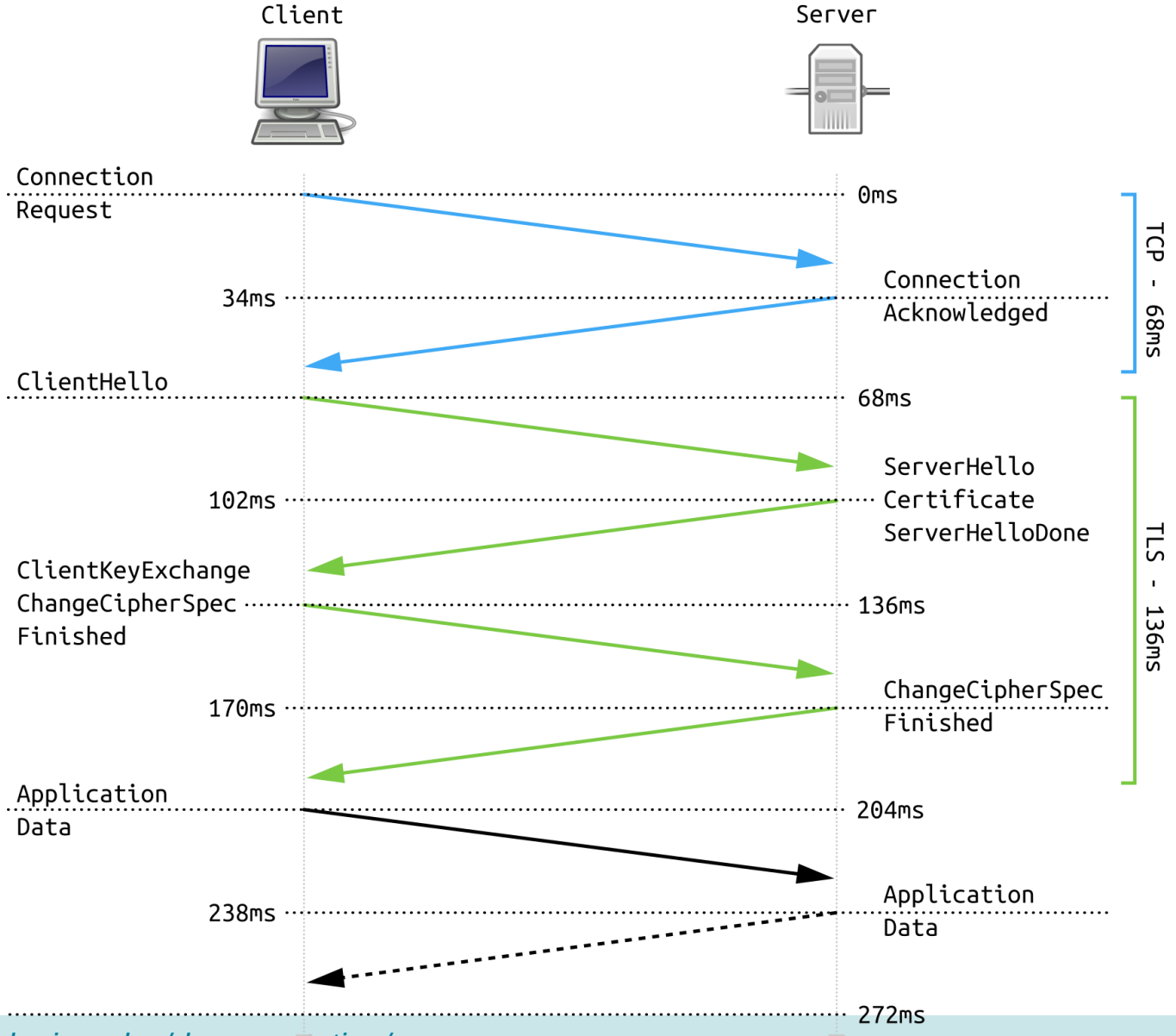
- Application level security – security settings specific for concrete application, can not be easily transferred to other applications and environments – secures data while inside application
- Transport layer security - HTTPS using SSL / TLS
- Message level security – using SOAP with Attachments for message exchange, encrypting message part when confidential

Transport Layer Security (TLS)

- Transport Layer Security (TLS) is a cryptographic protocol designed to provide communications security over a computer network. The protocol is widely used in applications such as email, instant messaging, and voice over IP, but its use in securing HTTPS remains the most publicly visible.
- The TLS protocol aims primarily to provide cryptography, including privacy (confidentiality), integrity, and authenticity through the use of certificates, between two or more communicating computer applications. It runs in the application layer and is itself composed of two layers: the TLS record and the TLS handshake protocols.
- TLS is a proposed Internet Engineering Task Force (IETF) standard, first defined in 1999, and the current version is TLS 1.3, defined in August 2018.
- TLS is the successor of the now-deprecated Secure Sockets Layer (SSL).

https://www.selenium.dev/documentation/

Simplified TLS 1.2 Handshake



Using Self-Signed Certificates

- keytool -genkeypair -alias springboot -keyalg RSA -keysize 4096 -storetype JKS -keystore springboot.jks -validity 3650 -storepass changeit
- keytool -genkeypair -alias springboot -keyalg RSA -keysize 4096 -storetype PKCS12 -keystore springboot.p12 -validity 3650 -storepass changeit
- keytool -list -v -keystore springboot.jks
- keytool -list -v -keystore springboot.p12
- keytool -importkeystore -srckeystore springboot.jks -destkeystore springboot.p12 -deststoretype pkcs12
- keytool -import -alias springboot -file myCertificate.crt -keystore springboot.p12 -storepass password
- keytool -export -keystore springboot.p12 -alias springboot -file myCertificate.crt

Spring Boot SSL Configuration

```
server.ssl.key-store: classpath:springboot.p12
server.ssl.key-store-password: changeit
server.ssl.key-store-type: pkcs12
server.ssl.key-alias: springboot
server.ssl.key-password: changeit

server.port=8443
```

Spring Security

- Spring Security is a powerful and highly customizable authentication and access-control framework. It is the de-facto standard for securing Spring-based applications.

- Spring Security is a framework that focuses on providing both authentication and authorization to Java applications. Like all Spring projects, the real power of Spring Security is found in how easily it can be extended to meet custom requirements.

Source: https://docs.spring.io/spring-security

Spring Security Features

- Comprehensive and extensible support for both Authentication and Authorization
- Protection against attacks like session fixation, clickjacking, cross site request forgery, etc.
- Servlet API integration
- Optional integration with Spring Web MVC
- Integrations - Spring Data, Jackson, Cryptography, etc.

Source: https://docs.spring.io/spring-security

Authentication

- Spring Security provides comprehensive support for authentication. Authentication is how we verify the identity of who is trying to access a particular resource. A common way to authenticate users is by requiring the user to enter a username and password. Once authentication is performed we know the identity and can perform authorization.
- Spring Security provides built in support for authenticating users. This section is dedicated to generic authentication support that applies in both Servlet and WebFlux environments.

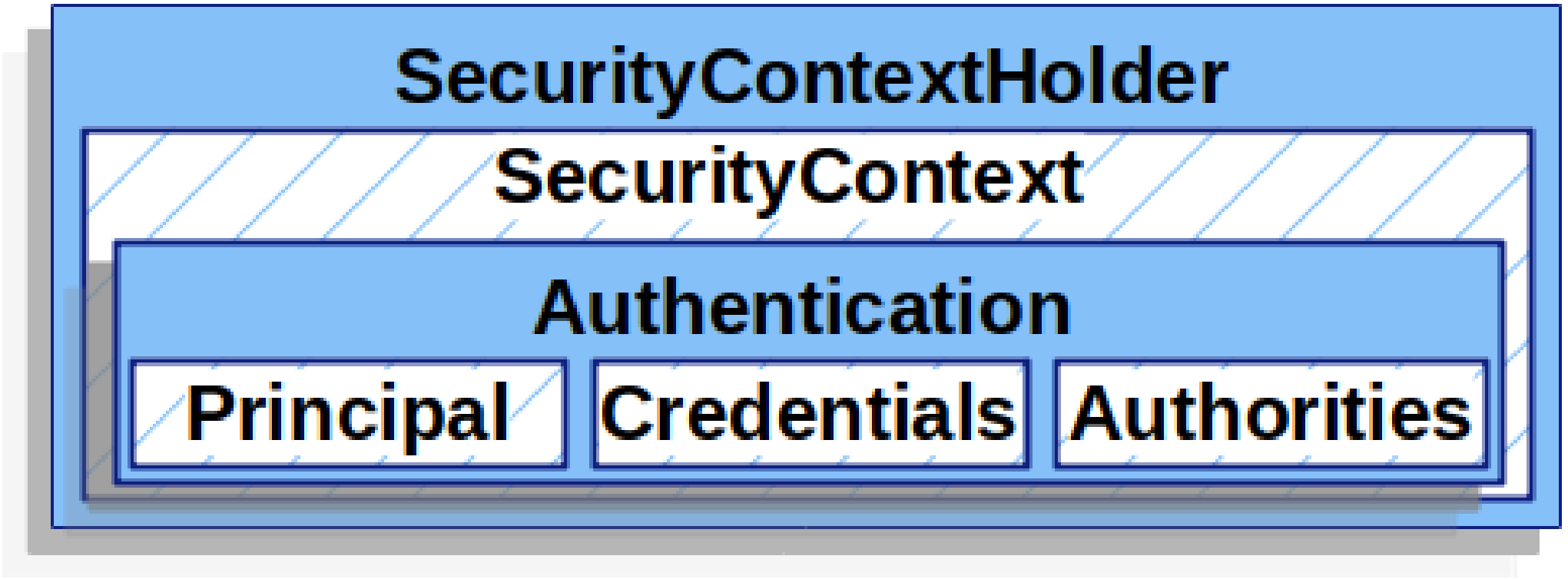
Source: https://docs.spring.io/spring-security

Authentication Mechanisms Supported by Spring Security

- Username and Password - how to authenticate with a username/password
- OAuth 2.0 Login - OAuth 2.0 Login with OpenID Connect and non-standard OAuth 2.0 Login (i.e. GitHub)
- SAML 2.0 Login - SAML 2.0 Log In
- Central Authentication Server (CAS) - Central Authentication Server (CAS) Support
- Remember Me - how to remember a user past session expiration
- JAAS Authentication - authenticate with JAAS
- OpenID - OpenID Authentication (not to be confused with OpenID Connect)

Source: https://docs.spring.io/spring-security

Spring Security Architecture



Source: https://docs.spring.io/spring-security

Spring Security Architecture – Main Parts

- SecurityContextHolder - The SecurityContextHolder is where Spring Security stores the details of who is authenticated.
- SecurityContext - is obtained from the SecurityContextHolder and contains the Authentication of the currently authenticated user.
- Authentication - Can be the input to AuthenticationManager to provide the credentials a user has provided to authenticate or the current user from the SecurityContext.
- GrantedAuthority - An authority that is granted to the principal on the Authentication (i.e. roles, scopes, etc.)
- AuthenticationManager - the API that defines how Spring Security's Filters perform authentication.

Source: https://docs.spring.io/spring-security

Spring Security Architecture – Main Parts II

- ProviderManager - the most common implementation of AuthenticationManager.
- AuthenticationProvider - used by ProviderManager to perform a specific type of authentication.
- Request Credentials with AuthenticationEntryPoint - used for requesting credentials from a client (i.e. redirecting to a log in page, sending a WWW-Authenticate response, etc.)
- AbstractAuthenticationProcessingFilter - a base Filter used for authentication. This also gives a good idea of the high level flow of authentication and how pieces work together.

Source: https://docs.spring.io/spring-security

Authentication

- The Authentication serves two main purposes within Spring Security:
  - An input to AuthenticationManager to provide the credentials a user has provided to authenticate. When used in this scenario, isAuthenticated() returns false.
  - Represents the currently authenticated user. The current Authentication can be obtained from the SecurityContext.
- The Authentication contains:
  - principal - identifies the user. When authenticating with a username/password this is often an instance of UserDetails.
  - credentials - often a password. In many cases this will be cleared after the user is authenticated to ensure it is not leaked.
  - authorities - the GrantedAuthoritys are high level permissions the user is granted. A few examples are roles or scopes.

Source: https://docs.spring.io/spring-security

Setting SecurityContextHolder

```
SecurityContext context = SecurityContextHolder.createEmptyContext();
Authentication authentication =
        new TestingAuthenticationToken("username", "password", "ROLE_USER");
context.setAuthentication(authentication);

SecurityContextHolder.setContext(context);
```

```
UserDetails user;
SecurityContext context = SecurityContextHolder.createEmptyContext();
Authentication authentication =
        new UsernamePasswordAuthenticationToken(user, "password", "ROLE_USER");
context.setAuthentication(authentication);

SecurityContextHolder.setContext(context);
```

Source: https://docs.spring.io/spring-security

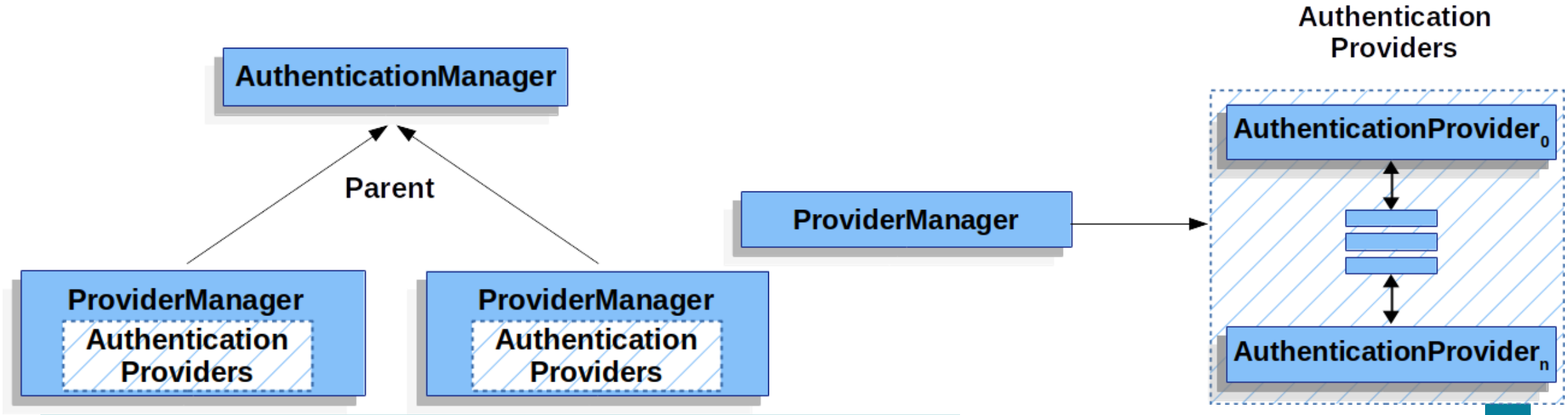
Accessing SecurityContext Authentication Programmatically

```
SecurityContext context = SecurityContextHolder.getContext();
Authentication authentication = context.getAuthentication();
String username = authentication.getName();
Object principal = authentication.getPrincipal();
Collection<? extends GrantedAuthority> authorities = authentication.getAuthorities();
```

Source: https://docs.spring.io/spring-security

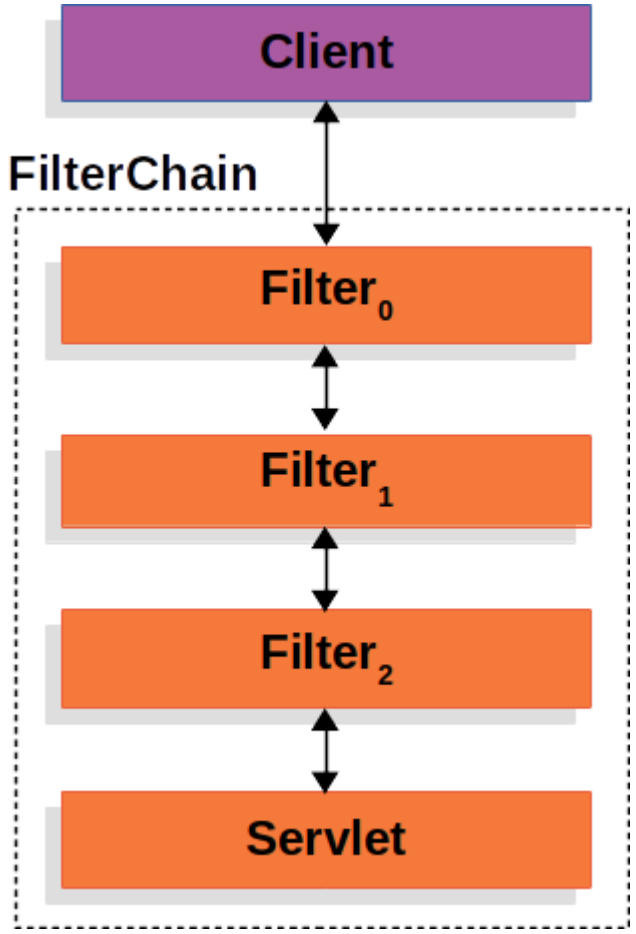
ProviderManager

- AuthenticationManager is the API that defines how Spring Security's Filters perform authentication.
- ProviderManager is the most commonly used implementation of AuthenticationManager. ProviderManager delegates to a List of AuthenticationProviders. Each AuthenticationProvider has an opportunity to indicate that authentication should be successful, fail, or indicate it cannot make a decision and allow a downstream AuthenticationProvider to decide.



Source: https://docs.spring.io/spring-security

Spring Security Architecture in Web Servlet Applications

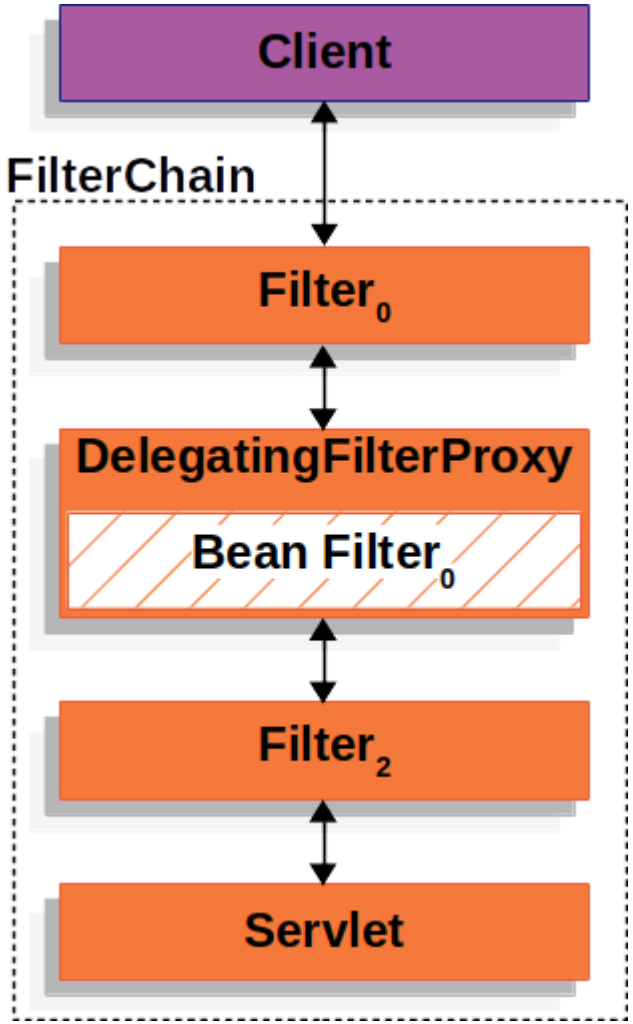



```
public void doFilter(ServletRequest request,
ServletResponse response, FilterChain chain) {
    // do something before the rest of the application
    chain.doFilter(request, response);

     // invoke the rest of the application
    // do something after the rest of the application
}
```

Source: https://docs.spring.io/spring-security/reference/servlet/architecture.html#servlet-filterchainproxy

DelegatingFilterProxy

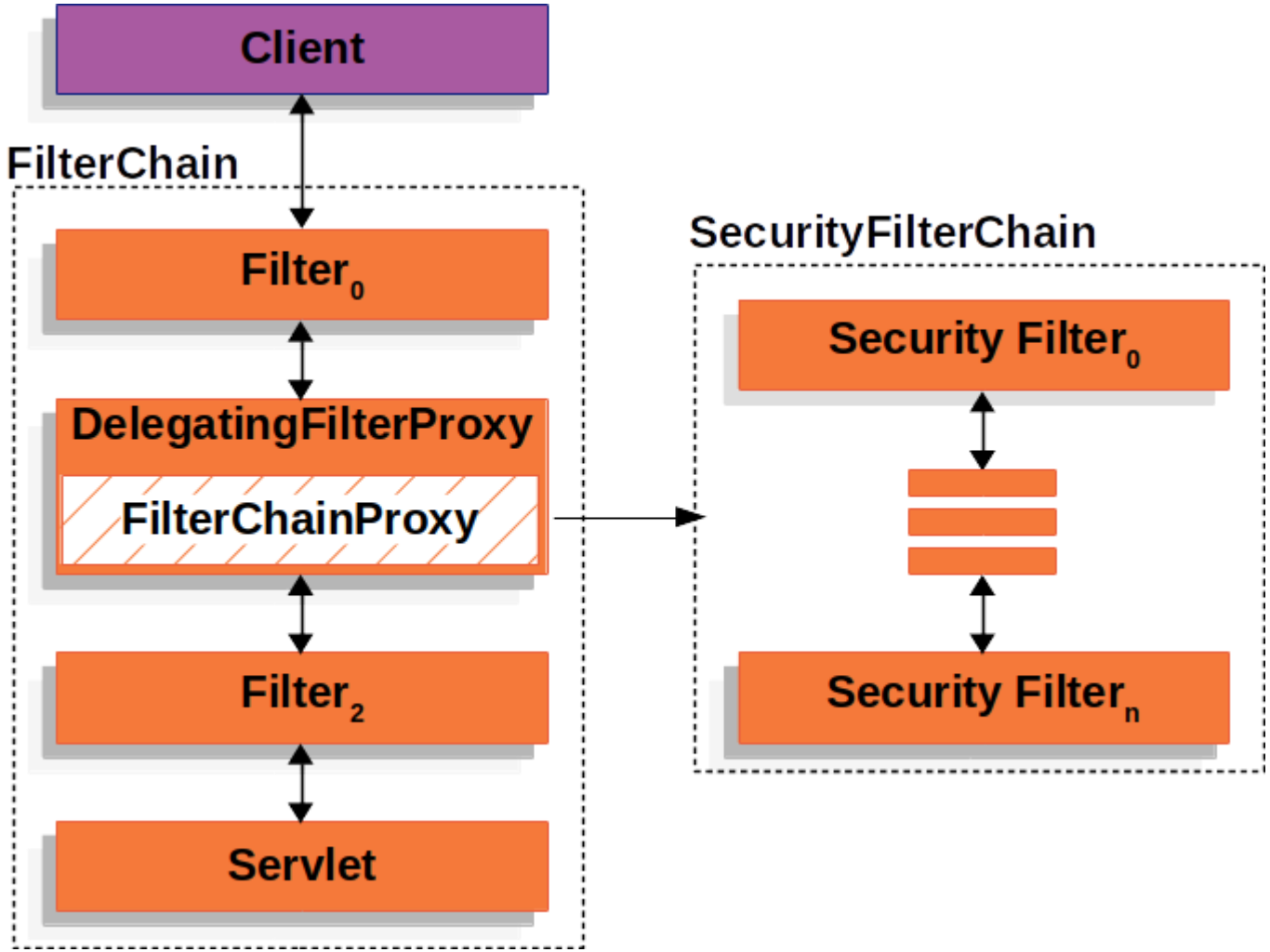



```
public void doFilter(

ServletRequest request, ServletResponse response, FilterChain chain) {
    // Lazily get Filter that was registered as a Spring Bean
    // For the example in DelegatingFilterProxy delegateis an instance
    // of Bean Filter0
    Filter delegate = getFilterBean(someBeanName);
    // delegate work to the Spring Bean
    delegate.doFilter(request, response);
}
```

Source: https://docs.spring.io/spring-security/reference/servlet/architecture.html#servlet-filterchainproxy

FilterChainProxy



Source: https://docs.spring.io/spring-security/reference/servlet/architecture.html#servlet-filterchainproxy

Security Filters - I

- ForceEagerSessionCreationFilter
- ChannelProcessingFilter
- WebAsyncManagerIntegrationFilter
- SecurityContextPersistenceFilter
- HeaderWriterFilter
- CorsFilter
- CsrfFilter
- LogoutFilter
- OAuth2AuthorizationRequestRedirectFilter
- Saml2WebSsoAuthenticationRequestFilter
- X509AuthenticationFilter
- AbstractPreAuthenticatedProcessingFilter
- CasAuthenticationFilter
- OAuth2LoginAuthenticationFilter
- Saml2WebSsoAuthenticationFilter
- UsernamePasswordAuthenticationFilter
- OpenIDAuthenticationFilter
- DefaultLoginPageGeneratingFilter
- DefaultLogoutPageGeneratingFilter
- ConcurrentSessionFilter

Source: https://docs.spring.io/spring-security/reference/servlet/architecture.html#servlet-filterchainproxy

Security Filters - II

- DigestAuthenticationFilter
- BearerTokenAuthenticationFilter
- BasicAuthenticationFilter
- RequestCacheAwareFilter
- SecurityContextHolderAwareRequestFilter
- JaasApiIntegrationFilter
- RememberMeAuthenticationFilter
- AnonymousAuthenticationFilter
- OAuth2AuthorizationCodeGrantFilter
- SessionManagementFilter
- ExceptionTranslationFilter
- FilterSecurityInterceptor
- SwitchUserFilter

Source: https://docs.spring.io/spring-security/reference/servlet/architecture.html#servlet-filterchainproxy

Basic Spring Security Configuration with Spring Boot

```
@Configuration
@EnableWebSecurity
public class SecurityConfig {
    @Bean
    public SecurityFilterChain securityFilterChain(HttpSecurity http) throws Exception {
        http.csrf().disable()
                .authorizeRequests().antMatchers("/**").permitAll();
        return http.build();
    }
    @Bean
    public HttpFirewall getHttpFirewall() {
        StrictHttpFirewall strictHttpFirewall = new StrictHttpFirewall();
        strictHttpFirewall.setAllowSemicolon(true);
        return strictHttpFirewall;
    }
//    @Bean
//    public WebSecurityCustomizer ignoringCustomizer() {
//        return (web) -> web.ignoring().antMatchers("/**");
//    }
}
```

More Advanced Spring Security Configuration

```
@Configuration
@EnableWebSecurity
public class SecurityConfig {
    @Autowired
    private JwtRequestFilter jwtRequestFilter;
    @Autowired
    private JwtAuthenticationEntryPoint jwtAuthenticationEntryPoint;
    @Bean
    public SecurityFilterChain securityFilterChain(HttpSecurity http) throws Exception {
        http.csrf().disable()
                .authorizeRequests()
                .mvcMatchers(POST, "/api/auth/login","/api/auth/register").permitAll()
                .mvcMatchers(GET, "/api/articles","/api/articles/**").permitAll()
                .mvcMatchers(GET, "/api/users","/api/users/**").hasRole(ADMIN.name())
                .mvcMatchers("/**").hasAnyRole(ADMIN.name(), AUTHOR.name())
                .and()
                .sessionManagement().sessionCreationPolicy(SessionCreationPolicy.STATELESS)
                .and()
                .exceptionHandling().authenticationEntryPoint(jwtAuthenticationEntryPoint);
        http.addFilterBefore(jwtRequestFilter, UsernamePasswordAuthenticationFilter.class);
        return http.build();
    }
}
```

JwtRequestFilter - I

```
@Component
@Slf4j
@Order
public class JwtRequestFilter extends OncePerRequestFilter {
    @Autowired
    private UserService userService;
    @Autowired
    private JwtUtils jwtUtils;
    @Override
    protected void doFilterInternal(HttpServletRequest request, HttpServletResponse response, FilterChain filterChain)
            throws ServletException, IOException {
```

(- continues on next slide -)

JwtRequestFilter - II

```
final String authorizationHeader = request.getHeader("Authorization");
String username = null;
String jwtToken = null;
if(authorizationHeader != null) {
    if (authorizationHeader.startsWith("Bearer ")) {
        jwtToken = authorizationHeader.substring(7);
        try {
            username = jwtUtils.getUsernameFromToken(jwtToken);
        } catch (IllegalArgumentException ex) {
            log.error("Unable to get JWT token.");
            throw new BadCredentialsException("Unable to get JWT token.");
        } catch (ExpiredJwtException ex) {
            log.error("JWT token has expired.");
            throw new BadCredentialsException("JWT token has expired.");
        }
    } else {
        log.error("JWT token does not begin with 'Bearer ' prefix.");
        throw new BadCredentialsException("WT token does not begin with 'Bearer ' prefix.");
    }
}
```

(- continues on next slide -)

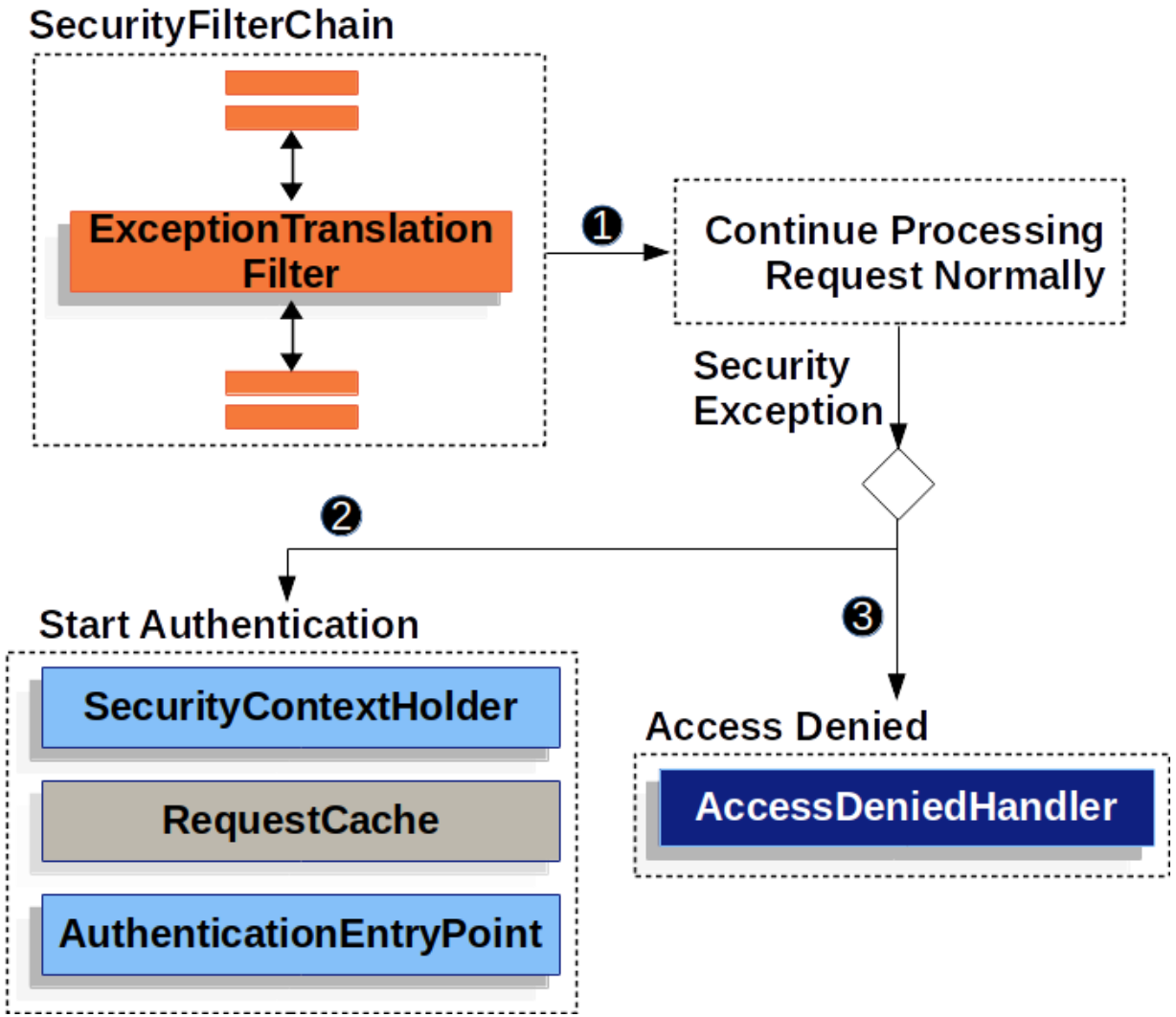
JwtRequestFilter - III

```
        if(username != null) {
            User user = userService.findUserByEmail(username);
            if(jwtUtils.validateToken(jwtToken, user)) {
                UsernamePasswordAuthenticationToken authenticationToken =
                        new UsernamePasswordAuthenticationToken(user, null, user.getAuthorities());
                authenticationToken.setDetails(new WebAuthenticationDetailsSource().buildDetails(request));
                SecurityContextHolder.getContext().setAuthentication(authenticationToken);
            } else {
                throw new BadCredentialsException("JWT token has expired.");
            }
        }
        filterChain.doFilter(request, response);
    }
}
```

JwtAuthenticationEntryPoint

```
@Component
public class JwtAuthenticationEntryPoint implements AuthenticationEntryPoint, Serializable {
    @Override
    public void commence(HttpServletRequest request, HttpServletResponse response, AuthenticationException authException)
            throws IOException, ServletException {
        response.sendError(HttpServletResponse.SC_UNAUTHORIZED, "Unauthorized");
    }
}
```

DelegatingFilterProxy



1. First, the ExceptionTranslationFilter invokes FilterChain.doFilter(request, response) to invoke the rest of the application.

2. If the user is not authenticated or it is an AuthenticationException, then Start Authentication.
   - The SecurityContextHolder is cleared out
   - The HttpServletRequest is saved in the RequestCache. When the user successfully authenticates, the RequestCache is used to replay the original request.
   - The AuthenticationEntryPoint is used to request credentials from the client. For example, it might redirect to a log in page or send a WWW-Authenticate header.

3. Otherwise if it is an AccessDeniedException, then Access Denied. The AccessDeniedHandler is invoked to handle access denied.

* If the application does not throw an AccessDeniedException or an AuthenticationException, then ExceptionTranslationFilter does not do anything.

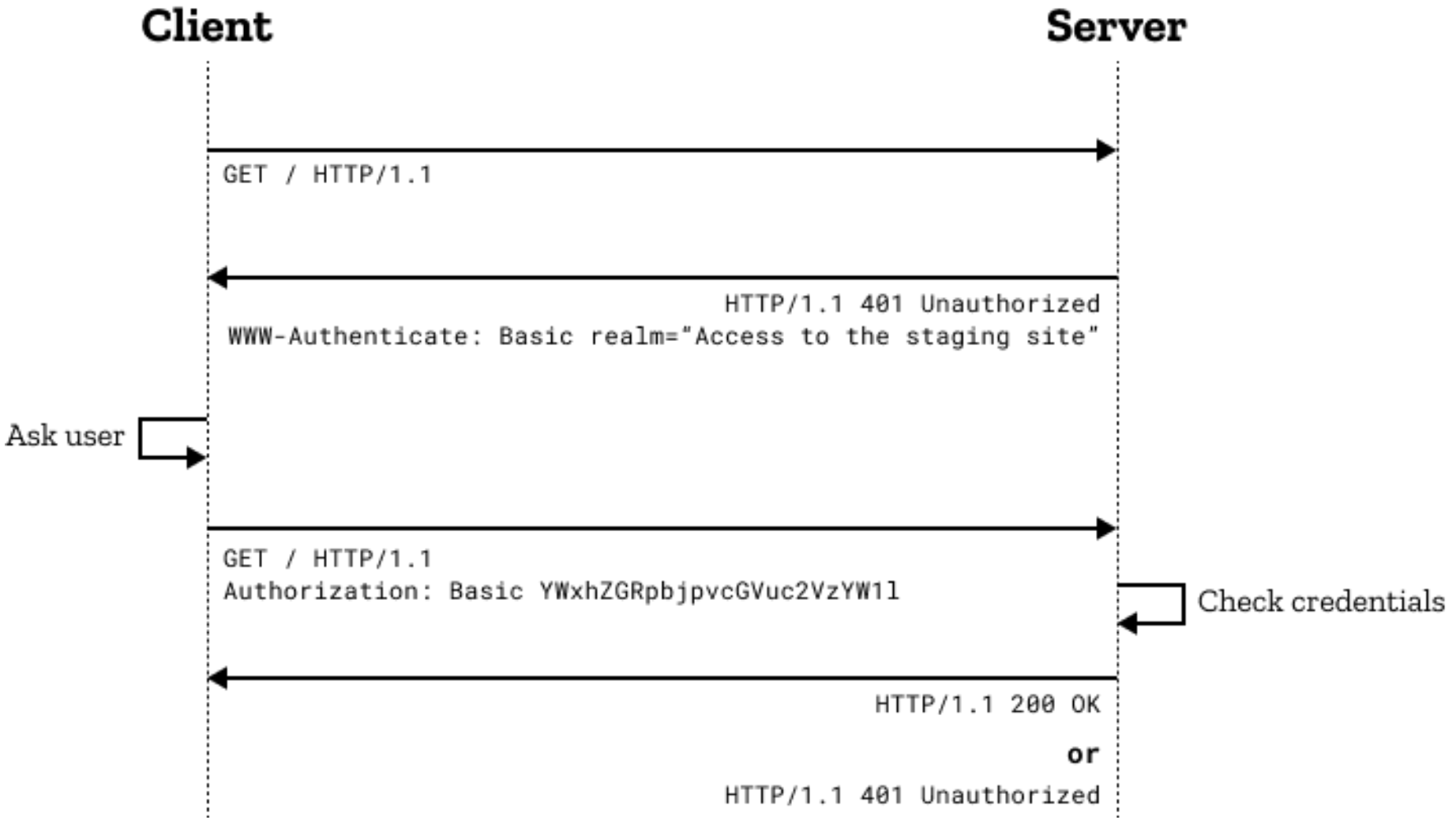
Source: https://docs.spring.io/spring-security/reference/servlet/architecture.html#servlet-exceptiontranslationfilter

WWW-Authenticate – Authentication Schemes:

- **Basic -** See RFC 7617, base64-encoded credentials. More information below.
- **Bearer -** See RFC 6750, bearer tokens to access OAuth 2.0-protected resources
- **Digest -** See RFC 7616. Firefox 93 and later support the SHA-256 algorithm. Previous versions only support MD5 hashing (not recommended).
- **HOBA -** See RFC 7486, Section 3, **H**TTP **O**rigin-**B**ound **A**uthentication, digital-signature-based
- **Mutual -** See RFC 8120
- **Negotiate** / **NTLM -** See RFC4599
- **VAPID -** See RFC 8292
- **SCRAM -** See RFC 7804
- **AWS4-HMAC-SHA256 -** See AWS docs. This scheme is used for AWS3 server authentication.

Source: https://developer.mozilla.org/en-US/docs/Web/HTTP/Authentication

WWW-Authenticate – Basic Authentication Scheme



Source: https://developer.mozilla.org/en-US/docs/Web/HTTP/Authentication

The OAuth 2.0 Authorization Framework: Bearer Token Usage

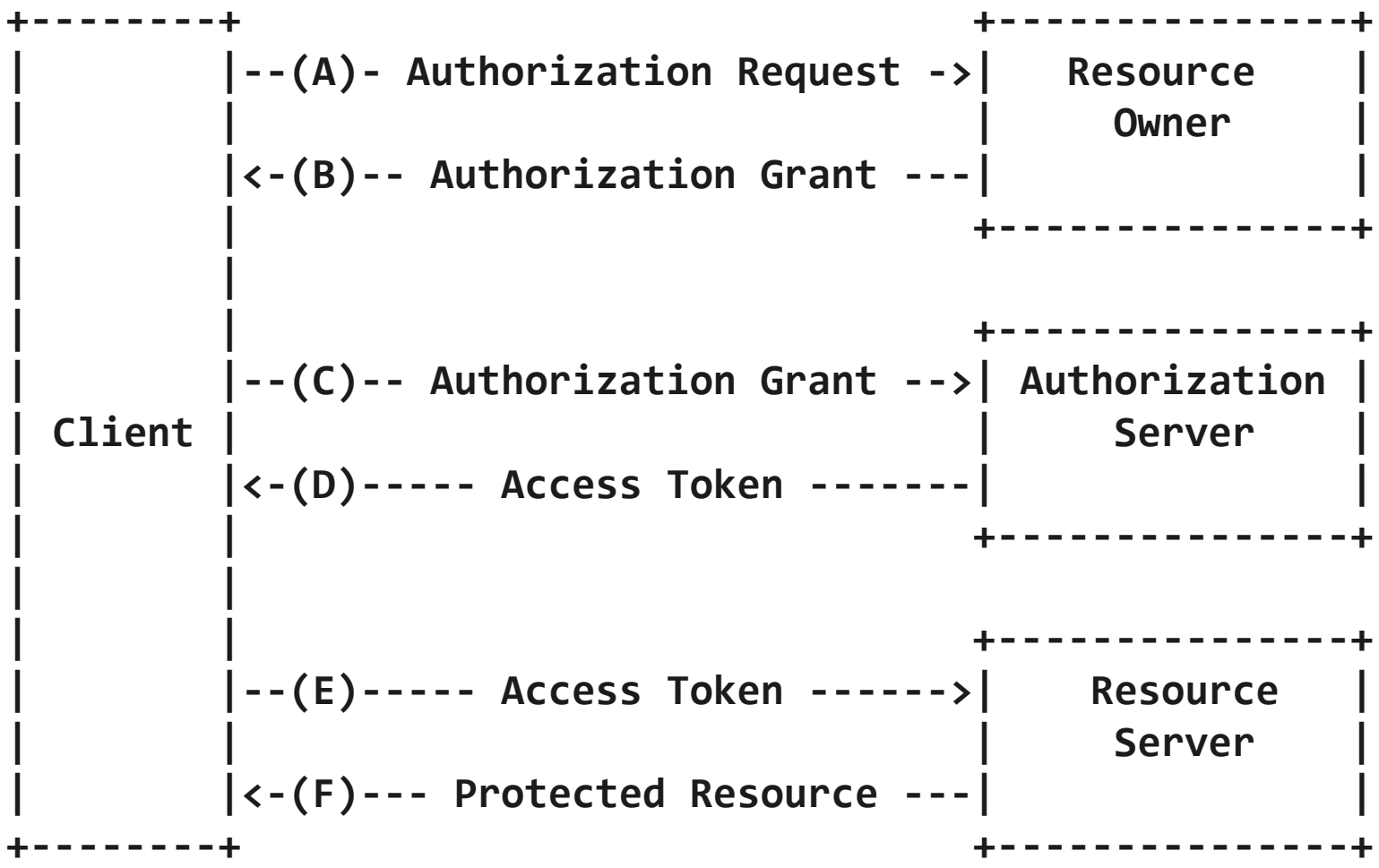


Figure 1: Abstract Protocol Flow

Source: https://datatracker.ietf.org/doc/html/rfc6750

WWW-Authenticate Response Header Field

- Example - the WWW-Authenticate Response Header Field:

  HTTP/1.1 401 Unauthorized

  WWW-Authenticate: Bearer realm="example“

- Example - the– token expired:

  HTTP/1.1 401 Unauthorized

  WWW-Authenticate: Bearer realm="example",
  error="invalid_token",
  error_description="The access token expired"

Source: https://datatracker.ietf.org/doc/html/rfc6750

Authorization Request Header Field

- Example Bearer token authentication request:

```
GET /resource HTTP/1.1
Host: server.example.com
Authorization: Bearer mF_9.B5f-4.1Jq
```

Source: https://docs.spring.io/spring-security

Method Level Security

```
@PreAuthorize("hasRole('USER')")
public void create(Contact contact);

@PreAuthorize("hasPermission(#contact, 'admin')")
public void deletePermission(Contact contact, Sid recipient, Permission permission);

@PreAuthorize("#c.name == authentication.name")
public void doSomething(@P("c") Contact contact);

@PreAuthorize("hasRole('USER')")
@PostFilter("hasPermission(filterObject, 'read') or hasPermission(filterObject,
'admin')")
public List<Contact> getAll();
```

Thank's for Your Attention!

Trayan Iliev

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